The ABC for Biomolecules and Bioparticles

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Avoiding of **B**ioseparations **C**osts (ABC) is a key aspect of any biotechnological process design, whether bulk fuels or high price biopharmaceuticals are concerned. The center piece is water removal, and therefore the best known diagram from biotechnological textbooks relates product cost prices to product concentration in a fermentation broth, in a double log-fashion. Water evaporation (24 MJ/kg) requires roughly a kilogram of hydrocarbons or coal at typical 50% energy efficiency. The energy penalty may be reduced by a factor of 10 by using multistage evaporation, distillation or vapor recompression, and further by using hybrid or membrane processes. Unfortunately, the energy penalty is increased by the (often) high degree of dilution of the product (typically 10 for ethanol and organic acids, 100 for butanol and antibiotics, and 1000 or larger for most pharmaceuticals). Even for bulk products and reasonably advanced process technology, energy costs range from 2-20 €ct / kg product at today's energy pricing.

Biomolecules. This is actually an interesting situation since solubilities of most bioproducts are essentially low, apart from those of ethanol and some organic acids. Concentration induced partitioning behaviour of biomolecules such as crystallization, precipitation and other S-L phase splits, as well as liquid –liquid phase split or other self-assembling behaviour, can avoid or reduce the necessity to remove water. Sofar, self-assembling behaviour has been mostly studied in the framework of phase-forming auxiliary materials (often specific surfactants or polymers). The "classical" recovery and make-up of these auxiliary materials contributes unfavorable to the products costprice.

Bioparticles. Similarly, partitioning of particles such as microbial or micro-algal cells to precipitate/floc-like 'solid' phases or to liquid/liquid or liquid/gas interfaces offers interesting options for reducing or avoiding water removal via conventional technologies such filtration and centrifugation. In particular, technologies based on reversible processes are expected to be attractive for cell retention of recycle systems. Low cost and efficient cell retention will help to establish the Holy Grail of Zero Growth Fermentation processes, in which complete conversion of carbohydrate feedstock to desired products is achieved and undesired biomass formation is avoided.

This contribution on **A**voiding of **B**ioseparation **C**osts (ABC) for Biomolecules and Bioparticles is meant to inspire the AFS community in their development of biobased options for global energy and chemicals supply.